Digital Schoolhouse: Playful Computing

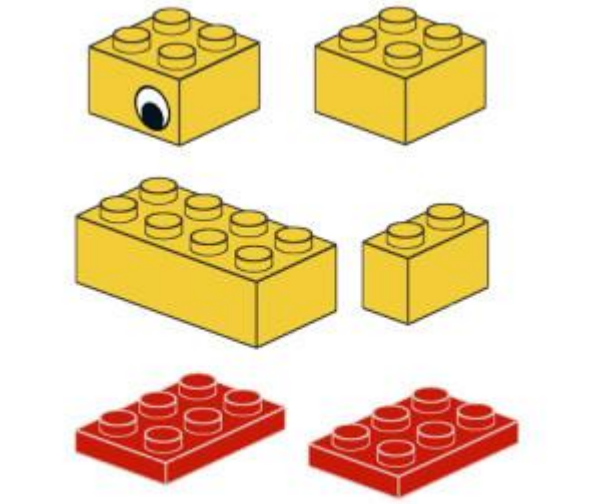
The Computational Thinking Duck

Age Range

+ Suitable for all ages

You Will Need:

+ 6 LEGO® bricks per student (for the main activity)
    - 2, 2x2 bricks (yellow)
    - 1, 2x4 bricks (yellow)
    - 1, 2x1 brick (yellow)
    - 2, 2x3 flat plate bricks (yellow)
+ A range of additional bricks for the extension activity
+ A digital alternative to LEGO bricks is the Virtual Lego Builder (https://www.buildwithchrome.com/)



This activity uses LEGO bricks to help develop computational thinking and creativity skills through play. The students should be encouraged to tinker, play and explore ideas to discover key concepts for themselves. The role of the teacher in this activity is to facilitate that learning and help students realise their discoveries and to embed and solidify the knowledge that they have gained.

Create packs of the 6 bricks ensuring that each student has the two red and four yellow bricks to enable them to create their own duck. Ask students to build a duck, give them no further instructions. Encourage them to get creative, see what they develop; each student should independently create their own duck and not attempt to follow their peers.

After each student has created their duck ask them to compare their ducks with that of their peers. This is a good point for discussion as all the ducks will be different. Ask the students to examine their ducks, why is each one different? The answer is because of the instruction given. Simply saying “Make a duck”; leaves how a duck should look open to interpretation. As humans we add our own prior knowledge and make the duck according to how we think it should look. However, computers do not have that ability, they simply follow the algorithm programmed within them.

The next part of the activity encourages students to examine algorithms in different forms.

Pair up students together. There are two distinct roles for the students to play, and both will take it in turns to play each role. One student will play the role of the 'programmer' and the other will be the 'human computer'. It will be the job of the programmer to describe their duck to the computer.

Verbal Instructions

Instruct the students to first give their partner verbal instructions to recreate their duck. It is worth noting that this activity can be repeated several times with different levels of questioning attached to each. For example:

- *Round 1* – free discussion between the pair, no restrictions
- *Round 2* – allow the (student) computer to give feedback on whether or not they understood the instruction, but not ask any questions
- *Round 3* – the (student) computer gives no feedback on the instruction, they simply execute the instruction given as best as they can

Engage students in discussion about the algorithms they gave their partners

- How successful was their algorithm?
- Did they have to refine their algorithm at all?
- How easy was it to describe their duck to enable their partner to recreate it?
- As the students worked through the rounds did the process become easier or more difficult?
- Round 2 and 3 begin to illustrate the importance of computer feedback and systems with well-designed error messages. What type of response from the student computer was the most helpful? Why?

Written instructions

Ask the students to write down the algorithm that would enable their partner to create the exact duck model that they have made.

Pair up students and tell them to swop instructions. Each student should test the instructions of their partner, are they able to recreate the same duck? Engage students in discussion about what they have found, for example some starting points may be:

- Give an example of a very good instruction – what made this a good instruction?
- Give an example of an instruction that was difficult to follow – why was this difficult?
- How long did it take to follow the algorithm?
- Were the instructions accurate?

Graphical Instructions

When LEGO issue building instructions for their kits, the algorithms are graphical rather than text based. Why? Ask the students to examine existing LEGO building instructions (https://wwwsecure.us.lego.com/en-gb/service/buildinginstructions).

- What is common about each set of building instructions?
- What are the differences between each instruction set?

- Why are they easy to follow?

Engage students in discussion about the importance of good algorithms. What have they learnt from the tasks they have carried out so far?

Ask the students to draw their own building instructions for their duck and then test it on a new partner. Engage the students in another short discussion to evaluate the result of this test. Help draw out the key elements of the activity and what makes the graphical representation of the algorithm so effective for the duck building exercise.

Evaluating Algorithms

Engage the students in discussion to compare the different algorithms that they have developed for their duck.

- Are the algorithms better written out or drawn?
- What difference does it make?
- Why?
- Which algorithm was easier to produce?
- Which algorithm was easier to follow?

The evaluation of the different algorithms can take a more formal approach by working with students to devise a set of evaluation criteria that they can then test. These criteria could include:

- The speed of the algorithm
    - the length of time it took to create the duck by following each algorithm
- The efficiency of the algorithm
    - Was the end result accurate?
    - How many errors were made by following the algorithm?
- How easy was the algorithm to follow?

Extension Activities

There are a range of activities that can be carried out using different coloured 6 bricks. The activity carried out can be easily extended, with students developing their own versions. Try the activities below:

Ask students to pick their own 6 bricks and then:

- Use it to create an object, i.e. a tree
- Develop an algorithm for the object
- Give the bricks (without the algorithm) to another person
- Do they create the object identical to yours?
- Now try it with the algorithm? Does it work?

Links to Computational Thinking

Where is the computational thinking in this activity?

This activity uses a range of computational thinking techniques. The key skill developed here is algorithmic thinking. With students formulating their own instructions that may be simply sequential or follow logical operations. Students work with their verbal instructions to create them in written form, which then may begin to see the introduction of programming concepts such as loops/iteration.

The construction of the duck enables them to touch upon abstraction and decomposition. For example, they need to be able to identify the different parts of the duck that can be represented through the six bricks, while this in itself is decomposition, abstraction enables them to realise that they will not create an exact replica of the duck. Key details about the features of a duck will need to be ignored if they are going to create their own model replica using only 6 LEGO bricks. Teachers can engage in discussion to help students see what details they automatically began to ignore about ducks.

Continuous evaluation enables students to constantly test and debug their algorithms. Key discussions around the effectiveness of different algorithms enable them to see if it is fit for purpose. Were there alternative solutions, what did their peers come up with? These are all valuable considerations and it is important if possible to enable students to try and arrive at their own evaluation criterion; this may be specific for each individual or a collective effort by the class to arrive at a common set of criteria that they deem suitable.

Tip: to ensure everyone contributes to the common set of evaluation criteria, ask each student to write their top 3 most important evaluation criterion on post it notes and then to stick them onto the board/wall etc. The teacher can then use these to identify the most common suggestions (and the most important ones) to help devise the class set.

Recommended Reading: Extend this with 6 Bricks

Did you enjoy this activity? This work has been developed in inspiration from the work of the LEGO Foundation and the six bricks project. Find out more about the project and download further activities and classroom resources from: http://www.legofoundation.com/es-es/programmes/play-based-learning/six-bricks

The 6 Bricks booklet sets out a number of activities to help students develop their problem solving, memory, creativity and movement skills. Many of these activities also serve as excellent ideas to help develop computational thinking, and delivered appropriately with the correct emphasis they will work for students of varying ages and abilities. Some of these activities have been pulled out below.

Back to Back

- Students stand back-to-back in pairs with the same three bricks
- One student builds a model and then explains to their partner how to build the same model
- The partner builds without looking or asking questions

- The pairs compare models and discuss how it went

The activity strongly emphasises algorithmic thinking and evaluation skills.

What Can You Build?

- Children use six bricks to build any creature
- They then take it in turns to describe their creature

This simple activity helps develop student's creativity and can fit in with any existing theme or subject within the school. There is some opportunity to consider abstraction here.

Build a Cube

- Build a cube with six bricks

This is a logical puzzle that will require logical reasoning to solve the problem. The students will be constantly evaluating their outcome and the activity can be extended to see:

- Who can do it in the fastest time?
- Writing an algorithm to create the cube

Sorting

- In small groups students mix their bricks together
- They then sort the bricks into piles of colour

It's clear to see how the bricks can also be sorted according to size or whatever other criteria you wish to establish. Different sorting methods could also be explored, such as bubble sort, insertion sort etc. LEGO bricks can be easily used to help students visually explore the different sorting techniques; who knows left alone to discover the best method they may think they have invented the bubble sort for themselves!

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W: **www.LEGOEducation.co.uk**

T: **https://twitter.com/LEGOeducationUK**